When the second light source **120** is used, the second light source **120** may directly emit the second light **121** to the transmission type shutter **130** without being thermally affected by the first light source **110**, the transmission type shutter **130**, and the image sensor **140**.

[0048] The transmission type shutter **130** may be an electro-optical device modulating light that passes through the transmission type shutter **130**. The transmission type shutter **130** and the first light source **110** may be modulated to have an identical frequency ω. For example, the first light source **110** may be represented as A sin(ωt) when the first light **111** emitted from the first light source **110** is modulated at frequency ω. When the first light **111** bounces off the object **180** and is reflected therefrom, the first light **111** may be represented as B+C sin(ωt+ϕ), that is, an intensity and phase of the first light **111** are changed. As the transmittance of the transmission type shutter **130** is also modulated at sin(ωt) while the first light **111** passes through the transmission type shutter **130**, an intensity of the first light **111** that passed through the transmission type shutter **130** may be represented as B sin(ωt)+C sin(ωt) sin(ωt+ϕ). The first light **111** may be received at the image sensor **140**, and an intensity of light measured in the image sensor **140** during one period may be represented as a periodic value of B sin(ωt)+C sin(ωt) sin(ωt+ϕ) integrated over time. B sin(ωt) disappears and only the term ϕ in C sin(ωt) sin(ωt+ϕ) remains after the integration. The period may be determined based on the frequency ω during a modulating operation. Since information, such as velocity, position, etc., of the light related to ϕ is superimposed during every 2π unit, it is possible to derive an accurate distance from ϕ by adding a fixed phase delay during modulation of the transmission type shutter **130**. For example, it is possible to derive a deviation by performing a photographing operation with the transmission type shutter **130** after delaying the light by a phase of about π/2, π, and 3π/2 and comparing respective light intensity information. In order to measure the deviation, the transmission type shutter **130** may have electro-optical characteristics whereby transmittance of the light through the transmission type shutter **130** changes with an applied voltage. As illustrated in FIG. **1**B, the transmission type shutter **130** may be an electro-optical device having a PIN diode structure. For example, the transmission type shutter **130** may be an electro-optical device using a multiple quantum well (MQW) method and may be formed on a GaAs substrate. Furthermore, the transmission type shutter **130** may be an electro-optical device using the Pockel effect or the Kerr effect. The PIN diode structure may include a P-type region **131**, an N-type region **133**, an intrinsic layer **132** provided between the P-type region **131** and the N-type region **133**, an anode **134**, a cathode **135**, and a power source **136**, which may be modified in various ways, as would be appreciated by an artisan having ordinary skill in the art.

[0049] Transmittance of the transmission type shutter **130** may vary with an applied reverse bias voltage. Referring to FIG. **1**C, an x-axis indicates a reverse bias voltage (−V) applied to the transmission type shutter **130**, and a y-axis indicates transmittance (%) of the transmission type shutter **130**. A region illustrated with dotted lines is an operating region due to an AC voltage and a DC voltage applied to the transmission type shutter **130**. Regarding the operating region, the DC voltage corresponds to a center position of the operating region, and operates the transmission type shutter **130**, which only transmits the light having a certain wavelength corresponding to the operating region. Regarding the operating region, the AC voltage corresponds to a swing component changing the transmittance into a sin, cos function type. For example, if the magnitude of the DC voltage applied to the transmission type shutter **130** is V_{dc}, and the amplitude of the AC voltage applied to the transmission type shutter **130** is V_{ac}, then, the transmission type shutter operates from $V_{dc}-V_{ac}$ to $V_{dc}+V_{ac}$. An amplitude of the AC voltage may be freely selected, but preferably, may be less than the magnitude of the DC voltage because, if the amplitude of the AC voltage is greater than the magnitude of the DC voltage, a voltage may be 0 V or lower in some parts during a swing process, and thus, the transmission type shutter **130** may not be operated. The magnitude of the DC voltage may also be freely selected, but preferably, may be in a range in which the transmittance linearly changes according to a change in a voltage. As an inclination of the linear section becomes steeper, a transmittance difference may become larger according to a change of a voltage. Therefore, distance precision of the 3D camera **100** may become higher by reducing noise. The inclination indicates a demodulation contrast and may be changed according to types and materials of the transmission type shutter **130**. A graph of FIG. **1**C is an exemplary graph of a GaAs type MQW transmission type shutter and may vary with a type of the transmission type shutter **130**. In the graph, a DC voltage of a reverse bias voltage is about −4.8V, and transmittance of the transmission type shutter **130** is about 40%. As an AC voltage is 0.8V based on the DC voltage, the reverse bias voltage may change from −4V to −5.6V. Therefore, the transmittance may change from 20.2% to 58.5%. The DC voltage and the AC voltage may be set such that the transmittance linearly changes. Since a point in time of when the reverse bias voltage is −5.8V in the graph corresponds to a last point of a linear part in the transmittance change, an operating efficiency of the transmission type shutter **130** may be reduced when the reverse bias voltage exceeds −5.8V. If it is required or desired to operate the transmission type shutter **130** in a region of −6V or higher, the magnitude of the DC voltage and the AC voltage may be determined so that the transmission type shutter **130** may operate in a region where a right inclination of the graph becomes a positive number.

[0050] Referring to FIG. **1**F, the transmission type shutter **130** has a transmittance of a peak value corresponding to a specific wavelength of an incident light and does not have uniform transmittance corresponding to every wavelength of the incident light. The peak value corresponds to a center wavelength of the transmission type shutter **130**. The center wavelength of the transmission type shutter **130** is a function of a voltage and temperature, and may change according to a reverse bias voltage applied to the transmission type shutter **130** and a peripheral temperature. When the transmission type shutter **130** is operated via the AC voltage, heat according to the operation thereof is generated to be proportional to a square of the AC voltage, and thus, the center wavelength of the transmission type shutter **130** may change due to a temperature change thereby. However, if the AC voltage is too low, the above demodulation contrast may become lower and cause deterioration of a function of the transmission type shutter **130**. On the other hand, if the AC voltage is too high, a voltage becomes 0V or lower as a voltage swing becomes too large, and the transmission type shutter **130** may stop operating. Therefore, the center wave-